

**Working as a Technical Artist: An Exploration of Character Rigging in Maya**


**An Honors Thesis (Art 490)**

by

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 12/12/12

**Ball State University  
Muncie, Indiana**

December 2012

**Expected Date of Graduation**

December 2012

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## **Abstract**

The goal of my thesis is to create a short DVD video—referred to as a *demo reel*—which showcases my skills as a technical artist. This demo reel will display my highest and most worthwhile achievements for character rigging in Maya. Each clip on the reel addresses a different aspect of character rigging that I've studied during my academic career. Taken altogether, this reel condenses the whole of my studies into an easily digestible form which allows those familiar with my discipline to judge my skills in comparison to other professional artists.

## **Acknowledgements**

I'd like to thank Andy Beane for his guidance and insight throughout my college career. His input was invaluable in helping me to choose and prepare for a career as a technical artist. I'd also like to thank my fellow animation students at Ball State University. As we moved through the program together they became like a second family to me. Finally, I'd like to thank the communities of digital artists who contribute to websites like CGTalk and Digital Tutors. The resources on these communal websites have proven invaluable to me throughout my studies.

## I. Artist Statement

I'm not prone to sudden fits of creativity, nor am I driven by a passion to voice personal opinions, or make scathing commentaries about society. Thus, I wasn't drawn to art because I wanted to express myself. Instead, I was drawn to art because the artistic process engaged me.

I am a great fan of what might be called “creative problem solving”—where a “creative problem” is a problem that has no unique solution, but instead an infinite set of possibilities wherein each possibility's quality can only be judged by a set of subjective aesthetic standards as opposed to an objective scale of truth. Much of my schooling in the arts came in this form of creative problem solving. From grade school to college, art instruction always boiled down to “make a piece about X, using material Y, in format Z.”

The possible solutions for any given piece were endless. The only thing that mattered was how well my particular solution stood up to aesthetic criticism. Looking at art this way makes it seem a bit dry and formulaic but for whatever reason, I greatly enjoyed this way of working. I'd go so far as to say that I actually enjoyed solving the formula more than I did making the final piece itself.

In all honesty, if I was left to my own devices, I'd likely not make anything at all. For me, the fun of art comes in solving creative problems, not in making final pieces. I tend to be content to just think about a project and sketch it out. Expressing an idea is usually enough to satisfy whatever creative impulse I may have had. Once the idea is put to paper, I rarely feel the need to take it any further. Indeed, my sketchbooks are filled with many ideas that might have turned into something interesting if I had the drive to act on impulse and made a full piece out of it.

The only reliable way to motivate me to actually create something is if someone else tells me to. In a certain sense, that's what drew me to animation. In animation you're not really working on your own personal projects. Instead you're a member of a large team of artists all of whom work together to further the creative vision of the director. It's a highly stratified place where groups of artists are separated out and each set is given its own set of responsibilities and tasks. The work comes and goes, flowing from one group of artists to the next until a finished piece emerges at the end of the production pipeline.

In short, it's an environment that's perfect for my particular flavor of creativity.

Within animation there are many disciplines to choose from, but one spoke to me in particular: character rigging. For those unfamiliar with the term, rigging is much like puppet making. Just like puppeteers, animators make virtual life by moving puppets, the only difference with computer animation is that all the puppets are digital.

But before the animators can manipulate the puppets, a rigger like me must first implement a control system that allows the puppets to move. It's my job to build the puppet's joints and to string it up with controls so that animators can move them around and breathe life into their characters.

Character rigging is all about problem solving and problems come in all shapes and sizes. My digital puppets aren't limited to humanoid characters. In computer animation, everything from door handles to helicopters requires the puppeteer's touch. The production might call for a seven headed dragon, a Siamese manticore, or humanoid robots that transform into toasters. Whatever strange and wonderful character gets dreamed up it's up to me to develop systems of deformation and control that will allow the animators to bring it to life.

In short, rigging is nothing but problems that need to be solved, and I love nothing more than solving problems.



## II. Significance

It's difficult to assess my work's significance by judging it aesthetically, not because it is overly abstract or intellectual, but because my work is never meant to be seen or noticed by the viewer.

I work in animation and animation is an odd discipline, odd because it is not the work of a single visionary artist—as is the case with some other art forms. Instead, animation is a cumulative effort that spans broad groups of people with vastly different skillsets and talents.

Artists working in animation belong to many unique disciplines, each of which is responsible for a different aspect of film production. It's similar in a certain respect to the old master-apprentice artist studios common during the Renaissance, where the work of creating a large commission would be divided up among many groups of artists within the studio. Some might draw only background figures, others might just mix pigments, and a master artist would oversee the entire production.

By this analogy, I am not the master artist. Instead, I am one of the many anonymous workers doing his small part to produce a grand masterpiece.

In this sense, my work is rather insignificant as I'm not the author of the content I produce, nor am I the last to touch what I work on. I'm an intermediary, and as such I can't really claim the final product as my own.

To better understand what it is that I do, let me describe animation and my place within it using an analogy. Imagine an enormous fresco. If this fresco were made like an animated film, it wouldn't be done by a single artist. Instead there would be many groups of artists who work together to make the final image a reality. There would be a group who come up with the subject of the painting—known as “story artists” or “concept artists” in animation. There would be a group of people who sketch out what the objects in the scene will look like—“modelers”—and another group who develop the poses for the figures and draw them in the final composition—“animators”. Finally, there would be a group of artists who would color the painting in by modeling light and shadow—“texture artists” and “lighters”.

My work falls under none of these disciplines. Unlike the artists I described above, what I do is completely hidden from sight in the final product. However, while my work may be hidden,

it is still vitally important to every step in the process. In this analogy, I wouldn't be responsible for creating any imagery, instead, I'd be the one who mixes the plaster, the one who makes the brushes, sets up the scaffolds and mixes the painter's pigments. My job would be to make all the tools that the other artists use to make the painting. While I have no say in the painting's subject or decide its final look, in a very real sense, without me there could be no painting.

This makes the significance of my work hard to judge. The final audience never even sees the work that I do, but without my work there would be no final product to view. This also makes my work hard to judge aesthetically since nothing is being "expressed" or "reflected" in my work. I just make tools. There is no narrative to what I do. There is only utility. You can judge my work based on how easy it is to use, how effective it is, or how cleverly it solves a problem, but you can't judge it by beauty.

It is not unfair to say that I am but a cog in the machine when it comes to the creation of an animated film, but in this machine every cog has its purpose and if a single cog goes missing, the entire machine grinds to a halt. I chose to enter the field of animation because I was inspired by the worlds it can create and the narratives that it can tell. I have no delusions of grandeur about what I do, but I do believe that by doing my small part I can help to further the art of animation and help to create worlds that have never been dreamt of before: worlds that will enrapture the next generation just as I was inspired by the visions of those who came before me.

That sentiment may not be inspiring to everyone, but it makes what I do significant to me.

### III. Influences

To a certain degree, the direction of my work is determined by the expectations of the animation industry. Depending on the path I wish to follow within this field, different things are demanded of me, and my reel must reflect those demands.

For what I intend to do—character rigging—my reel must demonstrate many different categories of work. Categories such as: full-body biped rigs, joint-based and blendshape-based face rigs, quadruped rigs, mechanical rigs and rigs demonstrating organic deformations. To round my reel out, I must also include examples of script writing and dynamic simulations as well.

This list of categories gives me a firm foundation to base my work off of, but it still leaves much to be determined. The real challenge of building a demo reel is in finding unique variations of these themes to base my projects around.

To this end, I look to inspiration from community sites like CGTalk and Tech-Artists.org. These websites are forums for the free exchange of techniques and knowledge within the fields of 3D animation. By reading through articles and participating in discussions with my fellow artists on these sites, I was able to determine the final direction my work was to take and establish which individual projects I should tackle. For instance, the mechanical cat rig featured in my reel was the result of a challenge posted on CGTalk which I participated in.

Additionally, viewing the reels of other technical artists was instrumental to informing my current body of work. In particular, the reels of Jeremy Ernst and Ozgur Aydogdu exerted a great influence on how I shaped my reel.

Jeremy Ernst is a character technical director at Epic Games—the makers of the popular Gears of War series. Ernst's reel is inspiring for the broad array of tools and knowledge it displays, featuring the many scripts and programs he authored during the production of Gears of War 3. What I found most enlightening was the genius of his solutions—such as using a pre-weighted, universal head mesh to derive every character's face—and the simplicity of his tools to the end user.

His reel was a stunning demonstration of a broad mastery of skills, and it inspired me to create more tools of my own. Further, the clarity of presentation in his reel serves as the guide I use for editing mine.

Ozgur Aydogdu takes a different approach with his reel. Instead of presenting a broad array of tools and projects, Aydogdu focuses on a single, exceptionally well-done piece: his character rig “Cenk”.

Aydogdu turned his reel into a careful and deliberate walkthrough of all the bells and whistles he piled into this single project. By doing so, he shows a depth of skill and an eye for detail that is awe-inspiring. Where Ernst’s work was focused more on simulating the natural world, Aydogdu’s is meant to emulate the paradigms of traditional animation through unnatural ranges of motion and cartoonishly exaggerated deformations—a goal which he achieved beyond all expectations.

Together, these two artists are the role models for my work. Ernst is my idol for the breadth of skill that I seek to demonstrate and my role model for physically-based rigging, while Aydogdu represents my ideal for the depth of skill I hope to address and sets the bar for quality in cartoonish rigging that I hope to attain.

By addressing both aspects of these rigging styles throughout my work, I hope to present the fullest picture possible of myself as an adept technical artist.



#### IV. Process/Technique

My work is goal-centric. Everything I do has an ultimate purpose and that purpose is most often solving a problem in animation production. These problems are often open-ended and the way I solve the problem is generally irrelevant so long as the solution works and is easy to use. This makes my job difficult, since I have free reign to try anything I can think of, so a big part of my process early on is narrowing my options down to a particular solution that I can focus my efforts on.

When I'm confronted by a new problem, I begin by first asking myself the question: "What have I done before that is similar to what I need to do now?" Past experience is often my greatest ally and if I've solved a similar problem before, then my previous solutions will hold the key to solving my current predicament.

Once I have a general idea about what I want to do, I turn to Maya to begin figuring out how I should go about doing it. I'll open up Maya and begin tinkering with the program to explore the problem further. In my experimenting, I'm constantly looking to Maya's documentation and online resources for guidance. I'll spend an extended period of time cycling between working in Maya itself and reading documentation online. I'll read a bit, and then test something out. I'll read a bit more, and then try something new. I'll repeat this cycle of research and testing many times until I have a firm grasp on how I should solve the problem.

After all this, it's time to put my ideas to the test in an actual production scene. During the tinkering phase, I work in a basic scene outside of the actual production pipeline. The pipeline is where all the final assets for the production are kept, so it's important that I do my tests elsewhere to keep myself from putting bad assets in the pipeline that could cause problems further on in the production. By the time I move on to an actual production scene, I'll have a good working knowledge of what I'd like to achieve and I'll have a stable and predictable solution to implement. Once I have the production scene open, I move into the next stage of my process: implementation.

This is a trying time for me, because I often run into problems I hadn't accounted for. As I mentioned before, when I'm developing a solution, I work in a scene that is outside the production pipeline. Because my test scene is outside of the pipeline, it is much simpler to use

and there are fewer things that can go wrong with it while I'm testing. But when I move my work from this sterile environment back into the chaos of the actual production, I have to deal with scenes that are much more complex and these new complexities often expose errors and problems within my solution. These problems—often referred to as “bugs”—require new rounds of testing and research to resolve.

This is the most trying time of my process. I'll think I have everything resolved, my test files work beautifully, everything seems fine, and then I go to implement my solution for real and I find some annoying error that forces me back to the drawing board. Then, once I resolve that error and think that everything's peachy, I come back with my new solution only to find that something else is going wrong.

It can be frustrating, but there's no way around it. I have to force my way through each bug, carefully and methodically diagnosing and resolving every problem I find. Eventually, I resolve all the bugs and I'll have a final product that's ready for the other artists in the production to use. This is one the happiest moments in my entire workflow: the moment when I can finally call my work done, mark the problem resolved, and push my solution down the production pipeline for other artists to use.

Unfortunately, my work is truly never done. As other artists use my work they'll frequently find more bugs or run into even further problems that need new solutions.

So, it's back to work again. I go back to the drawing board, re-work my solution, solve the newest problem and send it back to the other artists for approval. After every change I wait for feedback on new problems and issues. Eventually I get fewer and fewer problem reports as my solution becomes robust enough to stand up to the rigors of full-scale production, and at that point, I call my work done.

From there, things begin anew. There's always something else to be done: characters that need rigging, tools that need writing, dynamics that need simulating. As soon as I finish one project I move on to the next. It's all one great cycle that I'm stuck in until the entire production comes to an end. Then I can get a bit of rest before the cycle begins anew with the next production.



## V. Description of Selected Works

### V.a. Mechanical Rigs

Mechanical rigging poses many interesting challenges. In order to address these challenges in my work, I took on two projects rigging mechanical characters. My first project was rigging a model of a T-800 terminator's head—the T-800 is the version of the Terminator made iconic by the first *Terminator* movie. I chose this project as an introduction to mechanical rigging as the T-800 has a relatively simple and straightforward design that still poses some interesting challenges.

The setup for the spine and head was accomplished with a regular forward-kinematic joint chain. The real challenge of the head and neck was setting up the pistons and cords that connect the base of the neck to the T-800's skull. Aligning the pistons was accomplished via aim constraints. The top halves of the pistons were parented to the skull and the bottom halves were parented to the neck's base. This allowed for the tops of the pistons to move with the head while the bottom pieces remain stationary on the base. The aim constraints align the two pieces of the piston making it appear that the top piece is sliding into and out of the bottom piece as the head rotates.

The cords that extend behind the T-800's jaw posed a more difficult problem. Since the cords are flexible hoses, using the same aim constraint-based setup would produce an effect that's too rigid since the hoses wouldn't flex and bend as the head moves.

To grant them the flexibility they required, I used a spline-based inverse kinematic joint chain. With this set up, the ends of the hoses remain fixed in place, but the middle buckles and flexes as the character's head rotates. Additionally, controls placed along the hose can be used to adjust how the hose flexes, allowing the animators to shape the hose to achieve the poses they desire.

To me, the most interesting challenge posed by the T-800 head was the pistons that open and close its mouth. The main piston—the one that approximates the masseter muscle in human anatomy—could be set up via aim constraints just as the other pistons were, but the piston that extends from the sinus to the masseter piston was more challenging.

This piston connects a swing arm that extends from the T-800's sinuses to a sheath that slides along the masseter piston. The swing arm needed to rotate in two axes at two separate points in order to align with the sheath. After toying around with several solutions, I found that a hierarchy of aim constraints successfully orients the piston. One aim constraint rotates the base of the swing arm along its local x-axis causing the second portion of the swing arm to align with the sheath that slides along the masseter piston. Then a second aim constraint rotates the end portion of the swing arm around its local y-axis to finish its alignment to the masseter sheath. The end result of this setup is a seamless, automatic movement that keeps all the pistons aligned as the mouth opens and closes.

These solutions highlight two of the primary goals of rigging: hiding complexity and automating elements of the character. The animators who use this rig won't be interested in making sure that all the pieces align. Their primary point of concern is performance. They want to be able to manipulate the character into the poses they want with a minimum of fuss and hassle. Thus, to let the animators focus on their job of working on performance, I must automate as much of the character as possible and make the character as easy to use as possible.

## V.b. Elf Facial Rig

I made the elf facial rig as an exercise in smooth deformations. Unlike mechanical characters, organic characters require a type of deformation that allows for squashing and stretching the model's surface to simulate the flexibility of real tissue. This is accomplished by creating a "skin solve" wherein objects are placed under the surface of a character's mesh and then given a weighted influence that causes the character's mesh to be moved when you move the influence objects.

This process of creating influence objects and assigning them weighted values is called "skinning." A face is a particularly challenging object to skin, since people are so well attuned to the expressiveness of human faces. A lot of work goes into placing and weighting the influences just right to prevent the deformations from looking odd. That was by far the most difficult part of the project, since I had to align the influences to the various muscle masses on the face and make sure that they were oriented properly to slide underneath the skin like real muscles do. Then I had to take great care to weight the skin so that the movement of the joints caused the skin to react predictably and believably.

The next most challenging part of the process was creating an intuitive and easy-to-use control scheme for the face. Animation is a rapidly iterative process, where animators are constantly taking in feedback and tweaking their animations. Speed is of the essence when it comes to animation and that means that animators need to be able to pose characters as quickly and easily as possible. With this particular rig there are between 30 and 40 different influence objects used to mimic the face's muscles. This is entirely impractical to animate. To make the character smile alone would require the movement of more than ten different influence objects.

To simplify the controls on the rig I followed a multi-step approach detailed by Jason Osipa in his book Stop Staring. The control scheme works by creating a hierarchy of controls that move ever smaller portions of the face.

At the highest level of control, entire expressions are made by moving one control object. For example, one object can cause the character's entire face to move from a happy expression to a sad expression.

At the level immediately below that, there is a second set of controls that create components of expressions. For example, these controls let you raise and lower one of the eyebrows, cause a smile or frown on one side of the face, or allow each eye to blink or wince individually.

At the lowest level, there are controls that allow for tweaking the individual influence objects that affect the face. Using these controls it is possible to move small sections of the face, like the corner of the mouth, or the middle of the brow.

This control scheme gives the animators a high degree of control and responsiveness. By combining the three levels of control, an animator can quickly pose a character's entire face and then customize the expression with unique tweaks.

## VI. List of Work: Reel Breakdown

1. Terminator Rig | 0:03 – 0:12

Model made by dazzawalla on thefree3dmodels.com. Rigged and animated by me.

2. Mechanical Cat Rig | 0:13 – 0:29

Model made by Nico Strobbe on cgtalk.com. Rigged and animated by me.

3. Decapitation Rigs | 0:30 – 0:40

Model from student film Nerdvana. Animated by Dan Roberts, rigged by me.

4. Blend-shape Face Rig and Stretchy Body Rig | 0:40 – 0:48

Model made by Andy Beane. Blendshapes modeled by me. Rigged and animated by me.

5. Joint-based Face Rig | 0:49 – 1:00

Modeled by bitmapworld on turbosquid. Rigged by me.

6. Path Placement Script | 1:02 – 1:22

Script written by me in Python.

7. Prop Rigging Script | 1:23 – 1:35

Script written by me in Python.

8. Proxy Replacement Script | 1:36 – 1:46

Script written by me in Python.

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